FOREST INSECT AND DISEASE MANAGEMENT / evaluation report

Efficacy of Orthene® for Spruce Budworm Control in Maine 1975

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Introduction

Orthene®[1] is an organic phosphate insecticide of moderate persistence and apparent environmental safety. Of considerable importance, it has been found to possess some attributes of phloem-mobile systemic activity. This characteristic should lead to concentration of the chemical in the current-growth portions of a tree, the preferred site of spruce budworm feeding activity. An insecticide with such properties might affect the budworm in the early, bud mining stages, which are immune to most chemical treatments, and therefore provide greater than ordinary foliage protection. While trials of early applications are desirable, it seemed prudent to first evaluate Orthene against spruce budworm at the more traditional timing. This is when the bulk of the population is in the 4th larval instar; the insects are reasonably exposed to a contact spray, but unacceptable damage has usually not yet occurred to tree foliage.

Thus, the objective of this evaluation was to test the efficacy of Orthene against spruce budworm at a dosage and timing believed most likely to provide successful results. Upon achieving success, tests of alternate timings and dosages could be planned for future years.

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Methods

The dosage of Orthene selected for the project was ½ lb active insecticide in ½ gal of water per acre. This was applied to three 300-acre blocks in T14R6 and T14R7, Aroostook Co., Maine.

The spray blocks were established by taking 1 mile odometer readings along a gravel woods road and establishing each end of the mile as a corner. A 90 degree compass reading was taken from the road at the corners, and just under ½ mile distance chained to locate the back corners. Muslin sheets were erected in the tops of trees to mark spray block corners. The three plots adjoined each other in line along their short sides, thus reducing the number of corners to mark. The plots were designated OR1, OR2, and OR3.

The formulation of Orthene used was the 75 S; only water was added. Two Grumman Ag Cats equipped with sixteen 8008 nozzles were used to apply the spray. The nozzles were directed 45 degrees into the wind to increase atomization of the spray. The aircraft flew at 100 mph 75 ft above the trees with a 40 psi boom pressure during application. Plots OR1 and OR3 were sprayed simultaneously the evening of June 2; OR2 was treated by one plane the following morning.

Data on spruce budworm development, provided by the Maine Bureau of Forestry, shows approximately 18 percent, 70 percent and 12 percent of budworm larvae respectively in instars 3, 4, and 5 on June 2. These figures are means from four sampling stations in northern Maine.

Budworm population and defoliation sampling was carried out on transects that crossed the plots at right angles to the spray swaths. Each transect was a trail or skidder road, and 20 balsam firs were sampled along the transects in each sample period. Plot edges were avoided. A single 18-inch branch was collected per tree with aluminum pole pruners in the populations sampling. A cloth bag attached to the tip of the pruner was used in all but the prespray sample, when the small larvae are difficult to dislodge. Pruned branches were bagged in plastic and later examined in a field laboratory.

A prespray sample was taken on one transect of each plot on May 26. The first postspray collection was taken on the same transects on June 18; the second collection was taken on a second transect in each plot on June 25. At this time, a large proportion of the population had pupated.

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[1]Use of trade, firm or corporation names in this paper is for the information and convenience of the reader. Such use does not constitute an official endorsement or approval by the U.S. Department of Agriculture of any product or service to the exclusion of others which may be suitable.

Defoliation was sampled on four transects per plot during July and August. The procedure involved pruning 5 branch tips from the upper crowns of each of 20 fir trees per transect. Each current shoot on each branch was categorized as totally destroyed, partly damaged, or undamaged. The percentage of shoots in each category was then calculated for each tree. The percentage of shoots totally destroyed was multiplied by 2, the percentage partly damaged multiplied by 1, and percentage undamaged multiplied by 0, with the three products summed. This produced for each tree a defoliation rating on a scale of 0 (all shoots undamaged) to 200 (all shoots completely destroyed). The values for 20 trees were averaged to produce a defoliation rating for each transect. This system of rating defoliation is described in more detail by Dimond (1972).

At the end of summer, 30 transects in a variety of sprayed and unsprayed stands were selected for a comparison of the defoliation rating system described above with the Fettes system of defoliation estimation, widely used in Canada. The stands selected covered a broad range of defoliation levels, allowed the calculation of a regression relationship between the defoliation systems (unpublished), and conversion of the defoliation ratings taken on the Orthene plots to the percent defoliation result obtained with the Fettes system.

Spray deposit data were taken on two transects per plot, 10 sampling stations per transect. White Kromekote® cards and cards of Kodak Linograph® paper were simultaneously exposed on plywood squares placed on the ground along the population sample transects. A number of the cards were subsequently discarded when it was judged that the canopy opening above was of inadequate size.

Control data on populations and defoliation were derived in the same fashion as described above from single transects in untreated stands. Three stands are used here for comparison with population data on the sprayed plots. These three transects were all within two miles of the treated plots, and were sampled on the same dates as the treated plots.

Drop sheets, 4′ x 6′ unbleached muslin, were placed under clumps of fir trees, one in each treated plot and two in untreated plots. Spruce budworm larvae were collected from these drop cloths at several intervals after application.

Results

All three treated plots showed statistically significant larval reductions, in comparison to controls, in the first postspray collection (Table 1). The percent reductions were also significantly different. The difference was not statistically significant in the second postspray collection. This was due to the large numbers of survivors in plot OR1. That plot received very poor spray application, as is discussed later, and there is some justification for drawing the major conclusions from plots OR2 and OR3. The goal in attempting spruce budworm population reduction with insecticides is often stated as to reduce the number of surviving larvae to about one or less per branch. Orthene approached this goal on plots OR2 and OR3, which probably can be considered satisfactory in view of the unusually large spruce budworm numbers experienced in 1975. In past evaluations, prespray larval numbers have usually averaged between 20 and 50 per branch.

Defoliation was significantly less in all treated plots than in untreated plots (Table 2). As in population reduction, plot OR1 did not show as good protection as the remaining two plots, apparently due to application problems. Canadian reports (DeBoo and Campbell 1974, Miller and Varty 1975) suggest that 35 to 50 percent of the foliage saved is adequate for maintaining the life and relative vigor of fir trees. This was achieved on plots OR2 and OR3.

Several statements above refer to a poor application on plot OR1. Actually, nozzle plugging occurred during the treatment of both plots OR1 and OR3, but it was much more severe on plot OR1. The pilots reported that only two nozzles performed through the entire spray application on plot OR1, and that half, or about 8 nozzles, plugged on plot OR3. The problem was solved in the application made the following morning on plot OR2, and the application involved no mishaps. The nozzle plugging apparently derived from a formulation additive, Hi-Sol®, which congeals in the absence of agitation, but which rapidly returns to flowability upon agitation. This was noted in the mixing tank before pumping the spray into the aircraft. The tanks of the spray aircraft contained agitation equipment, however, the booms of the spray planes were primed with spray, and the additive apparently congealed within the booms during ferry to the plots, resulting in nozzle plugging almost immediately. The following morning, when plot OR2 was sprayed, the booms were first primed with water before filling the aircraft with spray. Thus, all of the spray load was agitated and no plugging occurred.

The numbers of droplets per cm^2 recorded on spray deposit cards are given in Table 3. The degree of nozzle plugging reported by the aircraft pilots relates well to the deposits measured on cards; and this in turn relates well to the levels of budworm population reduction and foliage preservation (Tables 1 and 2). Plot OR2 probably best reflects the efficacy of Orthene under the conditions of this evaluation.

Droplet sizes, as measured from Linograph paper cards, ranged from 150 to 525 microns, with a mean diameter of approximately 400. These are uncorrected for spread as a spread factor was not determined.

Drop sheet counts of dead budworm are given in Table 4. Unusual rates of drop, those significantly above the rates in untreated plots, occurred only until June 6-8, with the peak of drop occurring immediately following spray on June 4. This result appears consistent with Orthene acting primarily as a contact insecticide rather than a systemic.

Discussion and Recommendation

Orthene approached or met the usual criteria for success in controlling spruce budworm, both in terms of population reduction and foliage preservation. An exception was plot OR1. That result can be attributed to severe nozzle plugging, leading to very poor application.

The 1975 season provided a severe test of any material since larval numbers were at least double those involved in tests in past years (Chansler and Dimond 1971, Dimond 1974, Dimond 1972). In comparison with the insecticides used in operational control of spruce budworm in Maine in 1975, the Orthene results are favorable. Data provided by the Maine Bureau of Forestry show an average population reduction of 91.4 percent for Sumithion®, Zectran®, and Sevin 4 Oil®. These results are not strictly comparable with the Orthene results because of the different timing of the postspray samples, with Orthene samples taken later. The Bureau reports foliage preservation figures as 26 percent, 40 percent and 38 percent for Sumithion, Zectran, and Sevin 4 Oil respectively, based on visual estimations of foliage loss. Orthene surpassed these results.

Even allowing for the more exact timing of application possible in the small Orthene test, and the smaller aircraft employed and higher spray gallonage emitted, Orthene appears as effective as presently registered insecticides in protecting fir-spruce forests from spruce budworm damage.

It would appear that on the basis of efficacy at least, Orthene could be considered for registration for use aginst spruce budworm, particularly if 1975 produced corroborating results in tests in Canada and the western United States. Future testing should utilize larger aircraft, try spray gallonages reduced to one quart per acre, reduced dosages of Orthene, and earlier timing of application.

Pesticide Precautionary Statement

This publication reports pilot control project results involving pesticides. It does not contain recommendations for their use, nor does it imply that the uses discussed here have been registered. All uses of pesticides must be registered by appropriate State and/or Federal agencies before they can be recommended.

CAUTION: Pesticides can be injurious to humans, domestic animals, desirable plants, and fish or other wildlife—if they are not handled or applied properly. Use all pesticides selectively and carefully. Follow recommended practices for disposal at surplus pesticides and pesticide containers.

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Table 1. — Prespray and postspray budworm populations in plots treated with Orthene and in untreated plots, Aroostook County, Maine 1975

Plot	Prespray[1] Count	1st Postspray[1] Count	Percent[2] Reduction	2nd Postspray[1] Count
OR1	106	13.5	87.3	4.5
OR2	130	2.8	97.9	1.5
OR3	49	1.5	96.9	1.3
Untreated 1	69	22.9	66.8	3.0
Untreated 2	75	29.9	60.1	7.7
Untreated 3	64	30.5	52.4	12.7
F = [3]	1.49 N.S.	12.24 $p<0.05$	19.45 $p<0.05$	2.05 N.S.

[1]Budworm per 18-inch branch.
[2]Uncorrected for mortality in untreated plots.
[3]Analysis of variance between treated and untreated plots.

Table 2. — Defoliation assessment in plots treated with Orthene and in untreated plots, Aroostook County, Maine, 1975

Plot	Transect Number	Defoliation Rating	Percent Defoliation	Percent foliage Saved
OR1	1	166		
	2	176		
	3	162		
	4	149		
Mean		163[1]	70	30
OR2	1	118		
	2	114		
	3	116		
	4	110		
Mean		114[2]	48	52
OR3	1	114		
	2	113		
	3	143		
	4	160		
Mean		132	55	45
Untreated	1	199		
	2	199		
	3	200		
Mean		199	100	0

[1]Value of F in comparison with untreated plots, $P<0.05$.
[2]Value of F in comparison with untreated plots, $P<0.01$.

Table 3.—Numbers of droplets per cm² registered on spray deposit cards in plots treated with Orthene, Aroostook County, Maine 1975

Plot	Droplets per cm²		Number of Cards
	Mean	Range	
OR1	2	0-5	13
OR2	17	6-52	20
OR3	7	1-13	9

Table 4. —Numbers of dead budworm larvae on drop sheets in plots treated with Orthene, Aroostook County, Maine, 1975

Plot	Date							
	6/4	6/5	6/6	6/8	6/9	6/10	6/11	6/18
OR1	325	106	66	29	24	3	20	0
OR2	247	92	28	12	11	12	0	1
OR3	230	162	79	59	16	12	12	1
Unsprayed 1	0	14	0	10	25	0	13	4
Unsprayed 2	0	8	0	4	13	0	9	6